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THE OIL-CONTENT, KEEPING QUALITIES AND
COMMERCIAL POSSIBILITIES OF PARA
RUBBER SEED.

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I.—INTRODUCTORY.

THE utilisation of Para rubber seed for various industrial purposes has been considered by commercial firms and planters in most countries where *Hevea* is under cultivation but little progress has been made beyond enquiries as to the possibilities of the trade. There may be other reasons, unknown to the writers, why the manufacture of rubber seed oil with its residual product has not been placed on a sound commercial basis, but it is certain that one of the influencing factors is lack of detailed practical and scientific information. It is proposed to give an account of the experiments which have been conducted by the Department of Agriculture, Federated Malay States and the Imperial Institute, London, in order to throw some light on the subject.

Some years ago, seed was in large demand for planting purposes and, as the price was attractive, planters naturally took advantage of this, when possible, as an outlet for the disposal of the crop. With the vast areas in, and coming into, bearing and the relatively small areas now being opened up for rubber cultivation in the Malay Peninsula it is obvious that there must be an enormous annual crop of seed which is unproductive. An estimated yield of rubber seed received from four outside estates, in this country, amounted to 652 tons which works out at 330 lbs. per acre per annum. It is difficult to obtain an average weight of seed per acre since the season, as well as the many varying conditions of different estates, has a considerable bearing on the crop. However, taking an average yield of 400 seeds per tree with 90 trees per acre then, the weight of 2,000 seeds being about 17 lbs., we arrive at a figure of 306 lbs. per acre which is in substantial agreement with the former estimate.

The weight of the shells is practically uniform, depending only on the small variations in size, while that of the kernels varies from full normal weight to as little as one-eighth thereof in the case of a shrivelled seed. A gunny sack holds, approximately, 10,000 rubber seeds.

III.—GENERAL DETAILS OF RECENT WORK.

The chemical work was carried out with two main objects in view—viz., to ascertain the oil-content of rubber seeds and to follow up any decrease in oil-content or increase in acidity consequent on any deterioration during storage. Further, it was considered specially important to ascertain whether the oil-content was a fairly constant quantity or whether different batches of seed yielded varying results.

As is well-known, seeds containing much oil quickly undergo various changes which often profoundly affect their most essential qualities. For example, loss of vitality is more especially noticed in seeds of high oil-content. Again, a kernel—about half of which consists of fat and containing some 10 per cent. moisture and 13 to 16 per cent. nitrogenous matter—loosely encased in a hard and more or less impervious shell might well, especially in the tropics and when closely packed for shipment, ferment, become rancid, or develop marked acidity consequent on the general decomposition of the seed. Acidity depends on age and on the amount of hydrolysis or oxidation undergone; it is not an inherent quality of the seed. Exposure to light has a marked effect in encouraging oxidation. Not only does the acidity itself reduce the value of an oil but the actual quantity of oil may suffer, or, in bad cases, the composition of the oil might be so changed as to render it valueless.

The fact that no figures had been published dealing fully and in a representative manner with these questions made it all the more desirable to undertake experiments designed to elucidate, along exact lines, the points outlined above.

Particulars as to Treatment and Storage.—Seeds were procured from 14 year old trees at the Experimental Plantation, Kuala Lumpur, in the early autumn crop of 1916 and collected during a dry day. They were not specially selected but consisted of seeds which had been on the ground a week or more as well as those newly fallen. In all cases collections were made on the same date, with the exception of samples Nos. 23 and 24 (*see* Table I).

The experiment is divided into two groups, namely, unhusked and husked rubber seeds—i.e., entire seeds and kernels.

Unhusked Rubber Seed.—The seeds were collected on the 8th of September, 1916, and 64 lbs. were weighed out for each test on the following day. Nos. 1 to 5 were packed in gunny sacks, and Nos. 6 to 10 in wooden boxes (no packing material; boxes completely filled) on the day of weighing; while Nos. 11 and 12 were sun-dried for three weeks and afterwards packed in bags. During the period of sun-drying the seeds were kept in store at night. The sacks and boxes were opened at the termination of their respective periods of storage and the condition and weight of the seeds were recorded;

full details are given in the table. The seeds packed in the sacks were all in excellent condition when inspected after storage, but those in the boxes were, in most cases, slightly mouldy. The sun-dried seeds packed in bags maintained a perfect state of preservation. It will be seen that there was a considerable loss in weight during the early stages of storage, but after a few weeks the weight remained more or less constant.

Husked Rubber Seed.—The seeds in tests Nos. 13 to 22 were collected on the 8th of September, 1916, and 64 lbs. weighed out for each test on the same day. Shelling, which was carried out by hand, was commenced on the 8th and completed by the 12th September. The unhusked seeds were sun-dried from the 13th to the 29th September, when Nos. 13 to 17 were packed in gunny sacks and Nos. 18 to 22 in wooden boxes (boxes completely filled; no packing material). The kernels were weighed on three occasions; namely, when shelling was completed, after sun-drying and at the termination of the respective periods of storage. In tests Nos. 23 and 24, 64 lbs. of seed, in both cases, were collected on the 25th September, and packed in gunny sacks on the 29th; these kernels were not sun-dried. The condition of the sun-dried kernels, after storage, was satisfactory with both methods of packing. The kernels which were not sun-dried showed signs of decay at the end of three weeks while after four months their appearance was distinctly bad.

IV.—DETAILS OF THE ANALYTICAL WORK.

One of the initial difficulties on the analytical side was the obtaining of a fair and representative sample, for it is inconvenient in a chemical extraction to work on more than about one ounce of each sample of seed. After certain preliminary experiments it was finally decided to take samples of about six to seven pounds each from the sixty-four pound packages. It was assumed that such a weight of the seeds or kernels, as the case might be, would fairly represent each package. The whole seeds were cracked with a hammer and then crushed between small diamond-grooved steel-rollers (a miniature rubber crêpeing-machine was used for the purpose). Before crushing any seeds for experimental purposes, however, the rollers were well "washed through" with spare seeds until they acquired a more or less constant greasiness and "surface." In this way a comparable condition of the rolls before and after crushing a given batch of seed or kernel was secured.

A representative sample, weighing about an ounce, was then extracted in a continuous extraction apparatus with petroleum ether (petrol). This principle of continuous extraction is applied largely on the manufacturing scale as well as universally by analysts. The residual meal from the first extraction was ground up in a mortar with sharp sand in order to break up still further any oil cells that had escaped the preliminary crushing, and again extracted with petroleum ether to remove the last traces of oil. In order to satisfy ourselves that this procedure really gave representative samples of the 64 lbs. lots, trial analyses of the same lot of unhusked *

* For reasons already stated the whole seed is much more liable to variation in oil-content than is the kernel.

seed were carried out and yielded 25.4, 25.9, and 26.0 per cent. of oil, so that the total error (due to sampling and inaccuracies of analysis) does not amount to more than a half per cent. Thus while the oil percentages in the table are shown to the nearest tenth per cent. it should be remembered when examining the figures from the point of view of constancy of oil-content that the ascertained accuracy of the process is not more than a half per cent.

Certain individual seeds were analysed with the following results:

1. A large selected seed of good appearance, dark husk; kernel slightly brown.
2. A large selected seed of good appearance, dark husk; kernel clean.
3. Small selected seed of good appearance, dark husk; kernel clean and oily.
4. Seed of faded appearance, kernel brown and apparently rotten.

	Oil in kernel. Per cent.		Oil in whole seed. Per cent.		Acidity; mg. KOH per gm. of oil.		Kernel on total seed. Per cent.
1.	53.3	...	26.1	...	23	...	49
2.	52.5	...	31.4	...	8	...	60
3.	51.8	...	23.5	...	16	...	45
4.	46.2	...	23.2	...	34	...	50

It will be seen from the above figures that even serious decomposition has little effect on the oil-content, while the figures in the main table show that properly stored seed is not apt to decompose at all. It may be of interest in passing to note the oil-content of certain well-known seeds. The figures, which are drawn from various sources, are merely approximate:

	Per cent.		Per cent.
Soya bean	...	Cocoa nibs	...
Beech nut	...	Gingelly (Sesamé)	...
Hemp seed	...	Hazel nut	...
Linseed	...	Brazil nut	...
Mustard seed	...	Almond	...
Castor oil seed (large)	...	Walnut	...
" " (small)	...	Ground-nut	...
Poppy seed	...		

V.—DISCUSSION OF THE RESULTS OBTAINED.

A consideration of the figures for oil-content at once shows that they are throughout of remarkable uniformity. Indeed in the case of the husked seeds the differences, even when the longer periods of storing are taken into account, scarcely exceed the known experimental variation of a half per cent. The greater variation in the unhusked samples is to be expected, for the husk of a shrivelled seed weighs, as a rule, as much as the husk of a full seed while, as already stated, the contents of a shrivelled seed is often only about one-eighth of normal weight. The immediate objects of the investigation are therefore attained.

TABLE I.

Unhusked Rubber Seeds.

Particulars.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.
Date of collection ...	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16
Total weight on 9-9-16	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.
Date of packing ...	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16	9-9-16
Method of packing ...	Bags	Bags	Bags	Bags	Bags	Box	Box	Box	Box	Box	Bags	Bags
Treatment ...	...	...	...	...	...	Packed after collection	...	...	...	...	Sun-dried for three weeks	...
Period of storage ...	3 weeks	6 weeks	2½ months	4 months	6 months	3 weeks	6 weeks	2½ months	4 months	6 months	3 weeks	4 months
Weight of seeds when opened ...	55 lbs.	51 lbs.	50 lbs.	48 lbs.	49 lbs.	57 lbs.	51 lbs.	49 lbs.	48 lbs.	48 lbs.	50 lbs.	49 lbs.
Date opened ...	30-9-16	24-10-16	25-11-16	17-1-17	29-3-17	30-9-16	24-10-16	25-11-16	17-1-17	29-3-17	20-10-16	18-1-17
Condition of seeds when opened ...	Excellent	Excellent	Excellent	Excellent	Good	Slightly hot and beginning to rot	Excellent. Top of box wet	Slightly mondy	Slightly mondy	Good	Excellent	Excellent
Moisture per cent. ...	...	9.0	7.4	8.4	8.0	...	10.6	8.6	9.8	8.4	...	7.6
Oil per cent. on seed	...	26.8	32.3	26.6	23.1	...	26.0	25.3	24.6	30.6	...	27.4
" meal " ...	...	...	...	...	...	...	...	...	...	...	...	...
" dried " ...	...	...	...	...	...	...	...	...	...	...	...	...
Acidity (mg. KOH per gramme fat) ...	...	20	34.9	29.0	25.1	...	29.1	27.6	33.4	29.5	...	29.5
	...	...	...	16	27	...	20	42	25	66	...	16

TABLE I—(cont.)
Husked Rubber Seeds.

Particulars.	No. 13.	No. 14.	No. 15.	No. 16.	No. 17.	No. 18.	No. 19.	No. 20.	No. 21.	No. 22.	No. 23.	No. 24.
Date of collection ...	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	8-9-16	25-9-16	25-9-16
Shelling ...	...	...	...	...	Commenced on	...	...	...	...	...	...	...
Date of commencing to sun-dry ...	13-9-16	13-9-16	13-9-16	13-9-16	13-9-16	13-9-16	13-9-16	13-9-16	13-9-16	13-9-16	Not sun-dried	Not sun-dried
Date of packing ...	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16	29-9-16
Weight of seeds on 8-9-16 ...	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.	64 lbs.
Weight of kernel on 12-9-16 ...	38 "	39 "	39 "	39 "	39 "	38 "	39 "	39 "	39 "	39 "	...	...
Weight of kernel on 29-9-16 ...	25 "	26 "	26 "	26 "	26 "	25 "	26 "	26 "	26 "	26 "	39 lbs.	39 lbs.
Method of packing ...	Bags	Bags	Bags	Bags	Bags	Box	Box	Box	Box	Box	Bags	Bags
Period of storage ...	3 weeks	6 weeks	2½ months	4 months	6 months	3 weeks	6 weeks	2½ months	4 months	6 months	3 weeks	4 months
Weight of kernels when opened ...	27 lbs.	28 lbs.	28 lbs.	25 lbs.	22 lbs.	27 lbs.	28 lbs.	27 lbs.	26 lbs.	24 lbs.	31 lbs.	25 lbs.
Date opened ...	21-10-16	12-11-16	6-12-16	18-1-17	29-3-17	21-10-16	12-11-16	6-12-16	18-1-17	29-3-17	20-10-16	18-1-17
Condition of kernel when opened ...	Good	Good	Good	Slightly mouldy	Good, but badly attacked by insects	Fairly good	Good	Good	Good	Good but badly attacked by insects	Slightly decayed.	Bad condition; hot and mouldy
Moisture per cent. ...	...	7.2	8.6	6.0	...	...	7.2	6.2	6.8	5.2	...	5.0
Oil per cent. on kernel	...	47.8	46.5	47.9	47.8	...	47.6	47.9	46.6	47.5	...	49.1
" meal " dried	...	...	...	...	...	...	...	...	...	...	...	...
Acidity (mg. KOH per gramme fat) ...	...	11	50.9	51.0	50.6	...	51.3	51.1	50.0	50.2	...	51.7
	...	...	...	19	37	...	11	...	9	30	...	10.9

TABLE II.

- (a) Total ash on the husks (20 gm.) ... 0.70 per cent. (on dry)
 (b) " " kernels (23 gm.) ... 1.83 " "

Ash Analyses.

	Water Sol.	Acid Sol. (by diff.).	Insol. (black).	Total.	MgO.	CaO.	K ₂ O.	P ₂ O ₅ .	Chlorine.	Insol. (chiefly insol. silica.)	Al ₂ O ₃ ; Na ₂ O; Fe ₂ O ₃ ; sol. SiO ₂ and diff.	Total.
(a)	37.8	49.4	12.8	100.0	7.9	9.4	38.6	16.8	...	12.8	14.5	100.0
(b)	44.8	46.0	9.2	100.0	18.6	3.3	37.2	28.6	0.5	9.2	2.6	100.0

Whence it may be concluded that the ash of the residual cake from kernels contains, approximately, twice the above percentages of mineral matter. The figure 1.83 is not in good agreement with the Imperial Institute figure for ash—*viz.*, 5.6 per cent. on the cake (or, converted, $5.6 \times \frac{5.5}{100}$ or 3.1 per cent. on the kernels). No doubt the extra mineral matter was introduced during crushing and would appear largely as insoluble silica and ferric oxide.

The nitrogen content of shells and kernels appears below :

Sample.	N. on dry shells.	N. on dry kernels.	Protein matter on dry shells per cent. (N. $\times$ 6.25).	Protein matter on dry kernels per cent. (N. $\times$ 6.25).
	Per cent.	Per cent.	Per cent.	Per cent.
1	0.22	2.67	1.37	16.7
2	0.19	2.42	1.19	15.1
3	0.23	2.25	1.44	14.1
4	0.25	2.46	1.56	15.4
Mean	0.22	2.45	1.39	15.3

The figure 15.3 per cent. on the dry kernels represents $\frac{15.3 \times 100}{5.5}$ or 27.8 per cent. on the residual cake after 45 per cent. of oil has been expressed from the kernels. This latter percentage is in good agreement with the Imperial Institute figure for crude proteins (*see* page 240).

The acid figure (Table I) is of value in so far as it shows the oil has little tendency to hydrolise with age. The figures themselves are not high and the fact that the acidity at the end of six months is practically the same as it was at two months shows that no important decomposition of the oil has taken place. It may be pointed out that any acid in the oil can be removed without difficulty.

Taking the experimental results as a whole it is clear that any slight decomposition that does take place when the sun-dried seed is stored has little effect on the quantity or quality of the oil. It may further be stated with confidence that sun-dried seed (average moisture content 8.6 per cent.) contains about 27 per cent. of oil, equivalent to $29\frac{1}{2}$ per cent. on the dried seed meal. Referring to husked seed—i.e., kernels, these after sun-drying (average moisture 6.4 per cent.) contain $47\frac{1}{2}$ per cent. of oil, equivalent to 51 per cent. on the dried meal.

VI.—UTILISATION OF THE SEEDS.

For fuller information regarding the uses of the seed reference should be made to the *Bulletin of the Imperial Institute* (London, 1913), Vol. XI, No. 4, p. 551 the following is a summary of the above made by the Imperial Institute authorities and, in view of its local interest, we reproduce it in full below.

“In order to ascertain the value of Para rubber seed oil for various industrial purposes, samples have been distributed by the Imperial Institute to a number of firms for technical trial. It has been pointed out already that the cake left after expressing the oil from the kernels would probably be suitable for use as a feeding-stuff and with a view to confirming this by actual feeding trials, supplies of the cake have been forwarded to the South-Eastern Agricultural College, Wye, so that feeding trials might be made. The results so far obtained in these two technical investigations are summarized in the following reports, to which are added the results of examination of samples of the kernels, cake, and oil forming part of experimental consignments.

TECHNICAL TRIALS OF THE OIL.

Paint and Varnish Manufacture.—Supplies were sent to three firms, whose reports are summarized as follows:

- (1) Oil proved very satisfactory for their purposes, being about equal to linseed oil. Valued at £25 to £30 per ton. (July, 1912);
- (2) Drying power less than that of linseed oil;
- (3) Less drying power than that of linseed oil, and not likely to replace it whilst prices are normal.

Linoleum Manufacture.—Samples were supplied to four firms, who each reported that, without further extended trials they could not adopt rubber seed oil as a substitute for linseed oil.

Soft Soap Manufacture.—A firm of oil-seed crushers stated that the oil would be very suitable for the manufacture of soft soap, and for this purpose would be about equal in value to linseed oil, or cotton seed oil.

Manufacture of Rubber Substitutes.—A firm to whom a sample of the oil was submitted thought it would probably be suitable for the manufacture of rubber substitutes.

Conclusions.—It has been pointed out previously that, though Para rubber seed oil is a drying oil, it dries less quickly than linseed oil, and is, therefore, inferior to this oil for those industrial uses to which linseed oil is particularly suited. When linseed oil is high in price, however, it has to be replaced by oils that are intrinsically inferior to it for these purposes.

FEEDING TRIALS WITH PARA RUBBER SEED CAKE.

Two series of feeding trials have been carried out at the South-Eastern Agricultural College, Wye, with Para rubber seed cake.

No saponin or alkaloids were present in the cake, and if any cyanogenetic glucosides were present, the amount was less than that necessary to yield 0.01 per cent. of hydrocyanic acid.

The report on the feeding trials conducted at Wye with this consignment of cake was as follows:

Cows.—A quantity of the cake was moistened and fed to cows. All except three, which are usually averse to new foods, ate it readily. The cake was dry and powdery, and was moistened before feeding for this reason. It was found to absorb about its own weight of water, and was more appetizing in this state than when fed dry. Several cows refused it in the dry state, but ate it readily when moist.

Three cows received the cake daily for five days, getting four pounds each day. They all ate it readily and no scouring or binding effects were noticed, nor did the milk or cream appear affected in any way.

Sheep.—The cake was fed in a dry state to sheep and was eaten fairly readily, some sheep ate their full allowance when it was mixed with other foods, but apparently had less liking for it when fed alone. No exceptional effects were noted.

A more extended feeding trial with $1\frac{1}{2}$ tons of Para rubber seed cake, made experimentally from kernels imported from Ceylon, was carried out at the South-Eastern Agricultural College during the later part of 1912 and the beginning of 1913. A sample from this consignment was examined at the Imperial Institute and gave the following results, which are compared with average figures for linseed cake:

	Para rubber seed cake.	Linseed cake.
	Per cent.	Per cent.
Moisture	8.75	11.6
Crude proteins consisting of ...	30.19	29.50
True proteins	24.85	—
Other nitrogenous substances ...	5.34	—
Oil	8.71	9.50
Starch, etc. (by difference) ...	41.74	35.54
Fibre	5.01	9.10
Ash	5.60	5.20
Nutrient ratio	1:2.0	1:2.0
Food units	139	133

Cyanogenetic glucosides were present in this sample, which yielded, approximately, 0.02 per cent. of hydrocyanic acid.

This cake probably represents fairly closely the material which would be marketed if Para rubber seed kernels were worked industrially on a large scale, and its composition may, therefore, be fairly discussed in comparison with linseed cake, which is the feeding cake chiefly used in the United Kingdom.

It will be seen from the above figures that Para rubber seed cake is strikingly similar to linseed cake in composition, and that what difference there is, is in favour of the former. The chief difference is in the quantity of "fibre," which is only 5.01 per cent. in the case of Para rubber seed cake, against 9.10 per cent. in linseed cake. It is to be remembered, however, that the item "starch, etc.," is a "difference" figure, and probably represent to a large extent different carbohydrates in the two cases. Thus in the case of linseed there is much mucilage, which accounts to some extent for the hardness of linseed cake. Para rubber seed cake, on the contrary, is soft and inclined to crumble easily, so that it probably contains but little mucilage. Like linseed cake, Para rubber seed cake may yield small amounts of prussic acid, and the amount furnished by this sample is rather high, but as will be shown later it produced no ill effects on the animals fed with the cake.

The following is a summary of the report received on the feeding trials conducted at Wye with this cake:

Sheep.—A group of store tegs accustomed to trough feeding were used for the experiment. The smallest admixture of the rubber seed cake with the usual concentrated foods was, however, detected by the sheep, and the cake was left uneaten. Even when the total food supplied to the sheep was reduced below maintenance requirements, and this low ration was continued for a fortnight, the sheep refused to eat the rubber seed cake. Mixtures of the cake and various other concentrated foods were also tried without success. Older sheep similarly refused the food, and in fact all attempts at feeding sheep with this sample of Para rubber seed cake failed.

Young Cattle.—The cake was fed to a pair of two-year-old fattening heifers, which readily ate the food. The quantity of cake was increased gradually to eight pounds per head per day, but this caused pronounced scouring, and even five pounds of Para rubber seed cake eaten daily with 56 lbs. of mangolds produced a slightly laxative effect on these immature animals, the latter quantity of cake should therefore not be exceeded, as a rule, for such cattle. Further experiments with another batch of two-year-old beasts confirmed this conclusion.

Two of the beasts were killed at the conclusion of the experiment, the butcher reported the carcasses to be of first class quality, and the beef of excellent flavour. One of these heifers had received six pounds of the cake per day for ten weeks.

Dairy Cows.—Six barren cows with an average milk yield of $1\frac{1}{2}$ gallons per day were used for the test, and were fed with increasing amounts of the cake, until at the end of a week each animal was receiving 14 lbs. of cake per day. The cake was the only concentrated food supplied to the animals, and the ration was continued for six days without any marked change in the animals' excreta. The ration being richer than that previously allowed, the yield of milk rose, but the percentage of fat in the milk was practically unchanged. Butter was made from the milk produced during the first three days and again from that of the second three,

and in each instance the texture, smell and flavour of the butter was considered to be unaffected by the change of concentrated food. The butter was of slightly paler colour than that obtained from the same cows on a concentrated food ration of bran, dried grains, oats, and Egyptian cotton seed cake.

Para rubber seed cake can thus be safely fed to dairy cows without fear of tainting the milk or adversely influencing the butter. Even the large quantity of 14 lbs. per head per day seems to be without noticeable effect when fed to mature cattle.

Full-grown Fattening Cattle.—The cows mentioned above were fattened while still in milk, the daily quantity of rubber seed cake being reduced from 14 lbs. to eight pounds and four pounds of other cake added. The cows remained in a very healthy condition, and maintained a high milk yield until they were intentionally dried off about a month before sale to the butcher. The increase in live weight over an average fattening period of nine weeks was 1.7 lbs. per cow per day, and the milk yield over the same period was 0.85 gallon per cow per day, the cows being in milk an average of six only of the nine weeks. Para rubber seed cake thus appears to be a valuable fattening food for cows, producing very satisfactory increases in weight in mature animals, and giving rise to no ill effect even when the feeding is continued for a considerable time.

The value of Para rubber seed cake as a food for cattle has been clearly established by these experiments. As the first sample of Para rubber seed cake was eaten fairly readily in a dry state by sheep, it would appear that the aversion of sheep to the second sample must have been due to some peculiarity which it possessed, or to some idiosyncrasy in the sheep used, and it will not be desirable to draw a definite conclusion as to the unsuitability of Para rubber seed cake as a food for sheep without further trials.

COMMERCIAL CONSIGNMENTS OF PARA RUBBER SEED KERNELS.

As the result of the work done at the Imperial Institute on Para rubber seed kernels, a considerable amount of interest in this product has been aroused among planters in Ceylon and the Federated Malay States, and among oil-seed crushers and others in the United Kingdom, and several experimental consignments of the kernels, oil and cake have been received and sold in the United Kingdom. The following particulars of such consignments of kernels crushed in the United Kingdom are of interest in this connection:

Kernels as received from Colombo.—These consisted of dried kernels in fair condition, though a few damaged kernels were present. On examination at the Imperial Institute the kernels were found to yield 45 per cent. of a pale yellow liquid oil with an acid value of 34.1.

Cake as received from the crushers.—This consisted of clean, friable, buff-coloured cake, which was found to contain 11.2 per cent. of a semi-solid oil, obviously composed principally of free fatty acids.

Extracted Oil.—This was a clear, liquid, brown* oil, which gave the following results on examination, compared with those for samples of Para rubber seed oil from kernels in good condition previously examined at the Imperial Institute.

	Present sample.	Previous samples.
Specific gravity at $\frac{15^{\circ}\text{C}}{15^{\circ}\text{C}}$...	0.925 ...	0.925 to 0.930
Acid value	40.9 ...	10.7 „ 16.8
Saponification value ...	188.5 ...	191.8 „ 192.1
Iodine value per cent.	143.3 ...	128.3 „ 131.4

The oil thus generally resembled the samples previously examined at the Imperial Institute. Its acidity, however, was high, and this factor was apparently the cause of the “feeding up” stated to have been observed in paint made with the oil. Experiments carried out at the Imperial Institute support this view, since the oil as received, when ground with white-lead, gave a pasty, stiff paint which did not spread well, whilst oil from which the free acid had been removed gave a paint which remained fluid and could be spread easily.

It has been found at the Imperial Institute that the acid value of the oil is usually higher when the latter has been prepared from old or damaged kernels, and it is possible that the rather high acid value in this instance is due to the use of kernels that had been stored for some time. The acidity is principally due to the condition of the seed which yielded the oil (see above); the increases from 34.1 to 40.9 being probably due to enzyme action during the crushing process.

The oil did not appear to contain any lipolytic enzyme, as its acidity did not increase on keeping, even under conditions favourable for the action of an enzyme.”

VII.—SUMMARY.

It should be remembered that the above-quoted report refers to experiments which are now some five years old.

At the beginning of our present experiments (September, 1916), a consignment of 30 tons was sent to Messrs. Rose, Downs and Thomson, Ltd., of Hull, for crushing and valuation. £50 per ton was obtained for the oil and the residual cake realized £8 per ton. At the time linseed oil stood at £60 per ton. The difference of £10 per ton may well be put down to the prejudice with which all new products have to contend. Fuller information regarding this recent 1916 consignment is not yet to hand but the figures just given show beyond doubt the unquestionable value of the oil. Indeed as far as can be foreseen rubber seed oil will occupy a place but little inferior to linseed oil, as soon as the world's markets have acquired confidence in the new product.

It should further be borne in mind that the percentages of oil shown in Table I represent the total oil-content of the seed. In ordinary practice from 5 per cent. to 10 per cent. of oil (reckoned on

* As extracted at the Department of Agriculture, F.M.S., the oil was of a pale yellow colour.

the cake) remains in the cake—i.e., the oil actually obtainable by expression will be some $2\frac{1}{2}$ per cent. to 5 per cent. less than is shown in the Table. Consequently the entire seed yields, say, 24 per cent. and the kernel, say, 42 per cent. to 45 per cent. of commercially available oil. It is scarcely necessary to point out that the value of the cake depends to a large extent on its oil-content, so incomplete expression, while not advisable, nevertheless enhances the value of the residual cake. Expressing experiments on a fairly large scale are now being carried out at the Department of Agriculture and will, when completed, provide more exact information on this point. Samples both of the oil and the residual cake will then be available for distribution among interested parties.

Much might be written of the enormous possibilities of Para rubber seed oil but it is sufficient to point out that this high grade oil requires hardly any refining, is obtained from a waste product available in great quantity, easy to collect, transport and store and easy to crush. It would certainly pay well in normal times to ship the seeds or kernels; yet, with every prospect of restricted freight facilities prevailing for many years to come, it would seem that shipping the oil is the better proposal. Moreover, oil keeps far better than seed and is more conveniently stored. Comparative feeding experiments carried out locally on rubber seed, gingelly seed (sesamé) and copra cakes would prove of considerable interest.

Finally, the production of rubber seed oil would not interfere with the market for coconut oil or sesamé, as these oils are used, essentially, as human foods in the form of margarine and cooking fats. They are never used for paints, varnishes, red and white lead, packing compositions for joints, etc.

THE BRINJAL OR EGG-PLANT.

(*Solanum Melongana*).

By J. N. MILSUM.

THE brinjal (Tamil, *katherikai*; Malay, *trong*), by reason of its easy cultivation and heavy cropping propensities is a vegetable which should be grown in every garden. Though eaten to a lesser extent by Europeans, this vegetable is much in demand by Asiatics and considerable quantities are raised by Chinese market gardeners. The brinjal must be classed as a vegetable that is only relished by Europeans after a taste has been acquired for it. The Tamil labourer, however, invariably uses the brinjal in his curry. On those estates where the coolies have their own vegetable gardens, brinjals of a sort are usually cultivated. The varieties grown are frequently poor and compare unfavourably with the improved varieties that have been placed on the market in recent years.

For the purpose of recording in detail the actual yields and cultural requirements of the improved varieties of brinjal, a few of these plants were kept under observation from sowing of seed to finishing of cropping, a period of six months. Two varieties were grown, one having a large cylindrical white fruit averaging $9\frac{1}{2}$ ozs. in weight and another bearing fruits of oblong shape and greenish-yellow colour averaging 11 ozs. in weight. The seed was originally obtained from Ceylon. The successful cultivation of brinjals depends to a great extent on a continuous even growth from seedling to maturity, checks during the seedling stage or when transplanting are sure to have a detrimental effect on the crop. Seedlings that become stunted in the seed beds are useless for planting out. As it is usually necessary to harden the young plants off before transplanting, care must be taken that this be done gradually. Where it is only desired to raise a small quantity of plants, the seeds are best sown in a large pot or box. The receptacle should be well-drained and filled with fine soil containing a fair proportion of humus and sand. Should a large number of plants be required the seeds may be sown in a well-prepared bed of fine soil and carefully shaded from heavy rains and strong sunlight. The seeds germinate rapidly and if sown in pots or boxes, the seedlings are ready for their first shift into single pots, in ten days from sowing of seed. If sown in nursery beds, they may be allowed to form two or three leaves and then be transplanted direct into their permanent quarters. The former method, though more laborious, is to be recommended, as the plants having been grown for a larger period under advantageous conditions have formed a good root system and consequently grow rapidly after transplanting. The land where it is desired to plant out the seedlings must be thoroughly chankolled several weeks prior to planting operations. Manure in the form of well-rotted cow dung is essential to ensure heavy cropping. A dressing of about one basket of manure to every 20 square feet should be applied and well dug into the soil. Seedlings should be planted out, if possible, during dull weather, when this is not possible shade

consisting of a few broad leaves should be afforded. A good watering will also assist the young plants especially if the soil is in a dry condition. The distance of planting for the improved varieties should be four feet apart in both directions. Though in India and elsewhere in the tropics, a lesser distance is usually adopted, the present trials have proved that the strong growing varieties, which attain a height of three feet, require plenty of room to develop properly otherwise the plants and fruit are likely to suffer from fungoid diseases. During the period of growth, until the fruiting stage is reached, which is from six to eight weeks from transplanting, all weeds must be kept down. The plants will also be benefitted by an occasional stirring of the surface soil. As the plants come into flower, they should be earthed up. Several of the longer leaves may be removed from each plant, this allows more light into the centre of the bush and assists pollination. Fruits which have not been pollinated continue growing, though at a very slow rate and never become large. The plants will continue to bear fruit for two to three months, though after two months the fruits fail to reach a large size and become spiny. In the present trials the plants finished producing fruit $2\frac{1}{2}$ months after the commencement of fruiting and were dug out and the land prepared for a leguminous crop. Twelve plants of each variety were grown. The following table shows the results obtained, the distance of planting being four feet by four feet throughout the plots:

Variety.	Yield of fruits per plot.	Weight of fruits per plot.
Round white ...	120 ...	$71\frac{1}{4}$ lbs.
Long green ...	98 ...	$67\frac{1}{2}$ „

This yield is similar to that obtained in Bombay, where on land under fairly high class cultivation, an out-turn of 16,322 lbs. was obtained.* The land referred to had been manured at the rate of 1,451 lbs. fish and 433 lbs. nitre per acre. To obtain large crops of brinjals in India, heavy manuring is resorted to.

Whilst the brinjals are cropping a few fine fruits should be selected as seed producers. The seed is mature when the fruits have turned a yellow colour and become hard to the touch. The fruit should then be plucked and the flesh carefully pared off leaving the core containing the numerous seeds intact. The core should then be placed in water and left for a day or two when fermentation will set in and the seeds will then fall away from the flesh. After separating the seed from the core, it should be carefully dried and stored.

The egg-plant is liable to many of the diseases which attack other solanaceous plants. No disease was, however, noted during the present trials. Several kinds of caterpillars were troublesome including the larvæ of the large Death's Head Hawk Moth; these are best kept under by hand picking.

* Watt. *The Commercial Products of India*, p. 1027.

"DISEASES AND REMEDIES."

THE following is extracted from the *India Rubber Journal*, Vol. LIV, No. 19, 10th November, 1917.

"We have on many occasions given a lead to those interested in research in connection with diseases on rubber plantations, and our sympathies and support will always be extended towards any officials who are engaged in such work. The importance of the work now being done by competent men in this country to foster plantation research work cannot be denied. It is because we view the whole subject of diseases and plant sanitation work so seriously that we deem it opportune to issue a warning to owners of plantations not to take the reports emanating from the East too literally. We have recently read reports from men specially trained in scientific work, and from well-known visiting agents, which suggest that the men who have written them have been in a hurry. There has been a lot of wasted energy in a competitive endeavour to get results published. In one paper we read that after treatment for a few weeks a definite cure had been effected, and a certain re-agent pronounced as the best available. Other reports dealing with experiments to eradicate the same disease with the same re-agent are by no means so definite. Certain diseases are treated in a very light manner by some experts, and just as seriously by others. By all means use all the talent available, and encourage every man with special knowledge to continue his investigations without any waste of time. Diseases wait for no one, and too much sound work cannot be done. But we do sincerely suggest that there be a little less haste and enthusiasm in the direction indicated, and that publication of results be deferred until ample evidence has been secured. Unfortunately, the many workers now in the East act more or less independently, and there is hardly anyone available who can be appealed to for help. In the meantime, we hope for more solid work and fewer publications, otherwise the charge of quackery which is now being formulated will certainly receive ample justification. We have no sympathy with the average business man who expects an immediate return for his contribution towards the cost of maintaining of a scientific staff. Such an unbusiness-like-way view is the result of incomplete knowledge and failure to grasp the full significance of the problems involved. If we had our way we would prohibit the publication of "results" until they had been carefully censored by some competent mycologist in this country, and a long interval of time had elapsed after the closing of the experiments. Bad advice on the means of combating the parasitic fungi now known to us may have appalling results."

Although taking strong exception to the suggestion that "results" should be submitted to "some competent mycologist" at Home, the writer in the main agrees with the article reproduced above; in as much as many articles and reports assume a final and authoritative tone on matters which must of necessity still be uncertain.

The case is, however, different when progress is reported from time to time in "Notes" or "Preliminary Reports," a custom which latterly has been adopted in the Department of Agriculture, Federated Malay States, with an explicit warning that suggestions put forward in such "Notes" are not to be regarded as final. As the writer of "Disease and Remedies" remarks, "diseases wait for no one,"—planters have a right to be kept in touch with the trend of scientific opinion as to the efficacy of the various remedies suggested.

Let us, however, by all means, follow ordinary scientific rules with regard to final and definite publications, and defer these as long as may be necessary for ample evidence to accumulate; incidentally, publications of "Notes" as suggested above, does away with one great reason for such pseudo-final articles—*viz.*, desire for priority.

W. N. C. B.

THE LIME REQUIREMENT OF SOIL.

IT is apparent from the report by a visiting agent on an estate in this country that certain figures or results obtained in the chemical analysis of a soil may be misunderstood and misinterpreted by planters. In a paragraph in the well-known paper *Truth*, in discussing the report on a certain estate, the visiting agent is stated in the report to have said that the Agricultural Chemist reported that the soil of the estate in question required 15 tons of lime per acre to neutralize the acidity of the first foot of soil. The visiting agent in commenting on this in his report states that this treatment was impossible on account of the cost and that in his opinion, such a heavy application of lime would probably kill the trees. The visiting agent is correct in his remarks, but has unfortunately misunderstood the term "lime requirement." Although the soil in question, which consisted largely of peat, would require the amount of lime indicated above, to neutralize entirely the acidity in the first foot of soil, this amount certainly has not been recommended by this department nor does the "lime requirement" figure infer that such a quantity must be added to be effective.

This figure is of value as a comparison of the acidity of different soils, in the recommendation of treatment by liming, but much smaller quantities of lime than indicated by "lime requirement" figures are effective in practice, in improving soils. In actual practice this has been found to be the case (*vide Agricultural Bulletin, Federated Malay States*, Vol. IV, No. 12, September, 1916).

In all cases, in reports on soils from estates, in which this figure is included, definite recommendations in regard to the amount of lime to be applied are given and the writer is certain that such an amount as 15 tons per acre, costing about \$240 per acre for the lime only, has never been recommended by the Agricultural Department.

B. J. E.

INDIAN IMMIGRATION COMMITTEE.

A SPECIAL meeting of the Indian Immigration Committee was held at Kuala Lumpur on 4th February, 1918.

There were present: The Acting Controller of Labour (Mr. E. W. F. Gilman), Chairman, the Principal Medical Officer (Dr. C. L. Sansom, c.m.g.), the Director of Public Works (Mr. R. O. N. Anderson), Messrs. W. Duncan, F. G. Harvey and E. E. Smith, with the Deputy Controller of Labour, Kuala Lumpur, (Mr. J. W. C. Ellis) as Secretary.

The meeting was called to consider the question of reducing the number of kangani licences. During 1917 it had been found that the number of kangani licences issued (11,410) was in excess of the number necessary to recruit the number of labourers it was possible to ship, resulting in unnecessary loss and expense to employers and useless waste of passage space on steamers to provide accommodation for the excessive number of kangannies. It was decided to limit the number of licences to be issued in 1918 to 6,000.

The principles on which these should be allocated were considered. It was agreed that the first consideration was to maintain existing labour forces and old established recruiting connections but new estates would also receive consideration. Individual employers will be informed of the number allotted to them. To avoid congestion the issue would be evenly distributed over the ensuing five months—i.e., February to June.

Those who have not replied to the circular from the Deputy Controller of Labour, Penang, stating their requirements should do so at once as no further licences will be registered for any employer whose application has not been received.

Various matters connected with recruiting were also considered.

The practice of recruiting for several estates of the same Company under a single designation or Tin Ticket number was condemned. Steps will be taken to ensure that the actual estates should be designated in the licence and a separate Tin Ticket number adopted. Employers are asked to co-operate in this matter.

Correspondence was read relating to the activities of certain European recruiters, who are attempting to establish a professional recruiting business in India and have sent circular letters to planters in Malaya.

Employers were warned against these persons whose activities are absolutely opposed to the policy of the Indian Immigration Committee and the Labour Department.

Correspondance was read from Dr. Ford, the Emigration Agent at Negapatam, commenting adversely on the practice of sending conductors to India to supervise recruiting.

In the particular case mentioned he was of opinion that the kangani would have done far more recruiting if there had been no conductor in India to interfere.

**MINUTES OF MEETING OF THE ADVISORY
COMMITTEE, DEPARTMENT OF AGRICULTURE,
HELD AT THE OFFICES OF THE DEPARTMENT, KUALA LUMPUR,
ON WEDNESDAY, 30TH JANUARY, 1918, AT 10.30 A.M.**

PRESENT:—Mr. B. J. Eaton (deputed by the Director of Agriculture) Chairman, Messrs. H. Armstrong, T. W. Hodge, L. A. Irving, J. D. McCulloch, L. Mooijaart and C. Ritchie.

ABSENT:—The Hon'ble Mr. R. C. M. Kindersley, C. Bell, W. de L. Brooke, W. S. Cookson, J. S. Ferguson, R. W. Munro and R. H. Phillips.

Messrs. A. L. Buyers and D. A. Ross, representing Johore, who had been invited to sit with the Committee during 1918, were also present. Mr. C. L. Bradburne, also representing Johore, was absent.

Messrs. F. W. South, G. E. Coombs and F. G. Spring attended the meeting.

Mr. B. Bunting, Assistant Agriculturist, officiated as Honorary Secretary to the meeting.

1.—MINUTES.

The minutes of the previous meeting held on 31st October, 1917, having been circulated were taken as read and confirmed.

2.—QUARTERLY PROGRESS REPORTS.

The quarterly progress reports of officers of the Department, having previously been circulated, were laid on the table and the Chairman invited discussion.

Mr. McCULLOCH asked whether any information was available with regard to the bad patches of rubber which were now being investigated.

Mr. EATON said that a number of such areas were now under observation and all he could say was that it had been found that the chemical and mechanical analysis of the soil was often as good in the case of the bad patches as the good ones indicating that some other factor was responsible for the inferior areas. He stated that some form of special cultivation such as dynamiting might possibly improve the condition of the areas in question. In some cases the inferiority of growth on such areas could be attributed definitely to the poor mechanical properties of the soils.

3.—STOCK BREEDING FARM.

The CHAIRMAN informed the meeting that the sub-committee for general experiments met on the 17th December, 1917, and discussed the advisability of establishing a Government Stock

Breeding Farm for improving the present live stock of the country. The sub-committee was unanimously in favour of the proposal and as this work was of such great importance to the country as a whole it strongly recommended that, if Government approved of the suggestion, arrangements should be made to proceed with the scheme without any unnecessary delay.

The proposal was submitted to Government and the present position was that he had been asked to put forward a complete scheme giving detailed estimates of cost and showing the benefits which are anticipated to result from establishing a stock breeding farm in this country when the matter will be given careful consideration by Government.

A suitable site had been provisionally selected in the Kroh district of Upper Perak.

4.—AGRICULTURAL CONFERENCE.

The CHAIRMAN explained that the General Committee of the Agricultural Conference met in Kuala Lumpur, on the 17th January, and discussed preliminary details in connection with the forthcoming Agricultural Conference. It had provisionally fixed the date of the Conference for the third week in August and appointed a small Executive Committee to draw up a detailed programme and make the necessary arrangements for inviting scientists from other countries to attend the Conference and read papers on the more important subjects included in the programme. The Chairman gave a list of the subjects which the General Committee of the Agricultural Conference proposed for the Conference meeting.

The CHAIRMAN read a letter from Mr. A. B. Milne, who was unable to attend the meeting, stating that, if at all possible, he was in favour of limiting the Conference to the single subject of "Pests and Diseases" and would suggest that scientific men from Ceylon, Sumatra and elsewhere should be asked to attend.

After some discussion the matter was put to the meeting and it was decided "that this Committee is of the opinion that it would be a mistake to limit the Conference to pests and diseases."

5.—ESTATE INSPECTION.

The CHAIRMAN reported that the sub-committee for pests and diseases had met and discussed proposals for drawing up a scheme of controlling inspection work of pests and diseases on estates. The sub-committee had carefully considered the matter and its suggestions were put forward in the report which had been circulated to the members of the Advisory Committee.

Mr. MOOIJART pointed out the importance of an adequate staff.

Mr. RITCHIE asked how many men would be required for inspection work.

Mr. SOUTH replies that with one mycologist or inspector to every 20,000 or 30,000 acres at least 40 to 50 men would be required.

6.—EXPERIMENTAL COCONUT PLANTATION.

The CHAIRMAN read a report from Mr. Munro on the working of Sipantas Estate stating that the cleaning up of the estate was proceeding in a satisfactory manner and with the present labour force of 450 coolies he estimated that 1,000 acres would be under cultivation at the end of 1918.

Owing to lack of sufficient surface drainage the cost of weeding had been somewhat heavy and an improvement in the drainage system would result in a large reduction on the weeding costs.

The CHAIRMAN suggests that with regard to the carrying out of experimental work this should be done in conjunction with the departmental committee for experiments who would in turn make suggestions to the sub-committee for general experiments of the Advisory Committee.

This was unanimously agreed to.

7.—COCONUT OIL EXTRACTION.

Mr. HODGE asked whether anything had been done with regard to Coconut Oil Extraction in this country.

The CHAIRMAN replied that with a view to encouraging establishment of oil mills locally, Government would grant a site for a factory at a nominal rent and also grant a loan against a mortgage. The Government had already approved of a reduction on railway freight on copra and coconuts from $\frac{1}{2}$ cent per pikul per mile to $\frac{1}{4}$ cent per pikul per mile.

The CHAIRMAN informed the Committee that Mr. Munro had kindly made enquiries as to the possibilities of such a scheme and from information obtained it would appear that a minimum of 120,000 pikuls of copra per year, or 14,000 acres of coconuts in bearing, would be required to justify the erection of a co-operative mill.

The oil mill might be run on the lines of the Kajang Central Factory. After 8 per cent. had been set aside for interest to shareholders and fair depreciation allowed on machinery the profit accruing was divided amongst the contributing estates according to the quantity of copra delivered.

After some discussion it is proposed by Mr. Mooijaart and seconded by Mr. Ritchie to hold a joint meeting of the sub-committee for general experiments and the sub-committee for the coconut experimental plantation and to invite Mr. MacGregor, late of the Singapore Oil Mills, together with representatives of coconut estates to attend the meeting.

This was unanimously agreed to.

8.—EXPERIMENTAL FARMS.

The CHAIRMAN reported that a special meeting of the sub-committee had been held to discuss the question of reserves for experimental farms in connection with the new agricultural industries when it was decided to ask for two reserves of 2,000

acres each on the Western Coast, one to represent undulating land and the other flat coastal land, in addition to two larger reserves of 5,000 acres each in Pahang. It was also decided to suggest to the Johore Government that a reserve might be established in that State.

It was agreed that unless some special arrangement could be made it would be impossible to start any of this work until after the war. Mr. Kindersley suggested and it was agreed that the only possibility was that Sir William Taylor might be able to find some experienced retired planter, ineligible for military service, who would be willing to serve in this matter for the period of the war.

The CHAIRMAN stated that after making exhaustive enquiries regarding reserves he had applied for an area of 2,000 acres in the Bangi Forest Reserve as the most suitable site for an inland farm and that he hoped to obtain a reserve in Lower Perak for a coastal farm. Two areas of land had been suggested by the District Officer, Lower Perak, as being suitable and these were still under consideration.

He was still in communication with the British Resident regarding the Pahang reserves and all he could state at present was that a site had been selected near Jerantut, in the Kuala Lipis district, and a further area on the Kuantan River was being considered.

With regard to Johore, the Commissioner of Lands and Mines had recommended an area somewhere near the railway line as being preferable to the suggestion of reserving an area at Batu Pahat.

The meeting terminated at 12.30 p.m.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of September, 1917.

District.	Mean Barometrical Pressure at 32° Fah.	TEMPERATURE.				HYGROMETER.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
		Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bharu ...	...	81.5	91.2	73.7	17.7	76.4	.810	72.9	75.0	...	7.84	2.60
Pahang, Kuala Lipis ...	...	80.52	88.9	72.93	15.96	75.34	...	...	...	...	7.03	1.68
Johore, Johore Bharu ...	...	...	87.65	72.87	14.78	...	...	...	...	...	11.98	...
Singapore, Kandang Kerbau ...	...	82.2	87.6	74.1	13.5	76.2	.866	...	79.3	...	10.88	2.24
Malacca, Durian Daun ...	29.787	81.7	89.5	71.0	14.5	78.8	.929	...	85.0	S.W.	6.51	2.00
Negri Sembilan, Seremban ...	29.881	80.5	88.3	71.4	16.9	76.6	.838	74.0	80.9	N.W.	3.87	0.68
" Kuala Pilah ...	...	81.3	89.6	70.8	18.8	78.3	.915	76.2	84.6	...	5.55	1.49
" Port Dickson ...	...	80.9	86.3	73.5	12.8	76.9	.849	74.2	80.9	...	6.07	1.11
Selangor, Kuala Lumpur ...	29.794	80.4	87.9	71.0	16.9	76.4	.836	73.7	80.4	N.W.	7.70	1.41
" Klang ...	...	80.0	84.5	72.6	11.9	76.0	...	...	...	...	3.72	1.45
" Kuala Selangor ...	...	...	87.8	73.8	14.0	...	...	...	...	...	5.21	1.64
" Rawang ...	...	...	90.6	...	...	...	...	...	...	...	6.83	1.33
Perak, Telok Anson ...	...	83.17	92.0	70.0	22.0	78.38	.906	...	81.0	...	3.26	1.18
" Ipoh ...	...	81.59	94.0	70.0	24.0	76.22	.834	73.81	78.0	...	4.99	1.22
" Taiping ...	...	...	...	...	...	75.96	.833	...	80.0	...	14.33	2.55
" The Cottage ...	114.0	80.80	93.0	61.0	32.0	...	...	...	...	...	19.52	3.74
" Parit Buntar ...	...	82.23	92.0	70.0	22.0	77.44	.878	...	81.0	...	6.33	1.57
Penang, Georgetown ...	...	82.6	89.7	72.1	17.6	77.5	.872	73.3	77.6	N.W.	8.89	1.45
Kedah, Alor Star ...	29.758	...	...	...	...	...	...	...	...	...	13.57	4.32
Perlis, Kangar ...	...	...	87.63	73.93	13.70	...	...	...	...	...	8.93	1.91